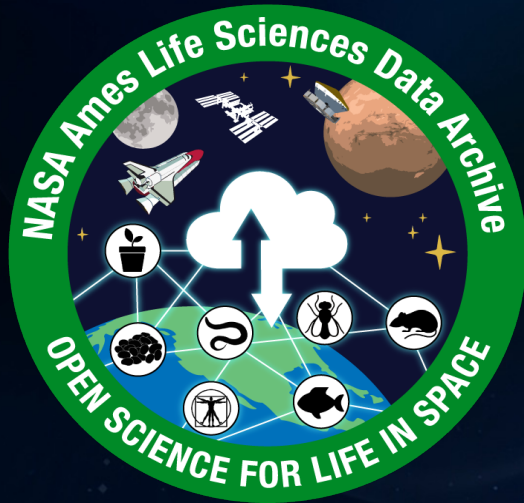
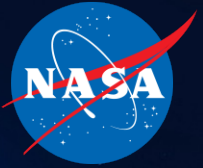


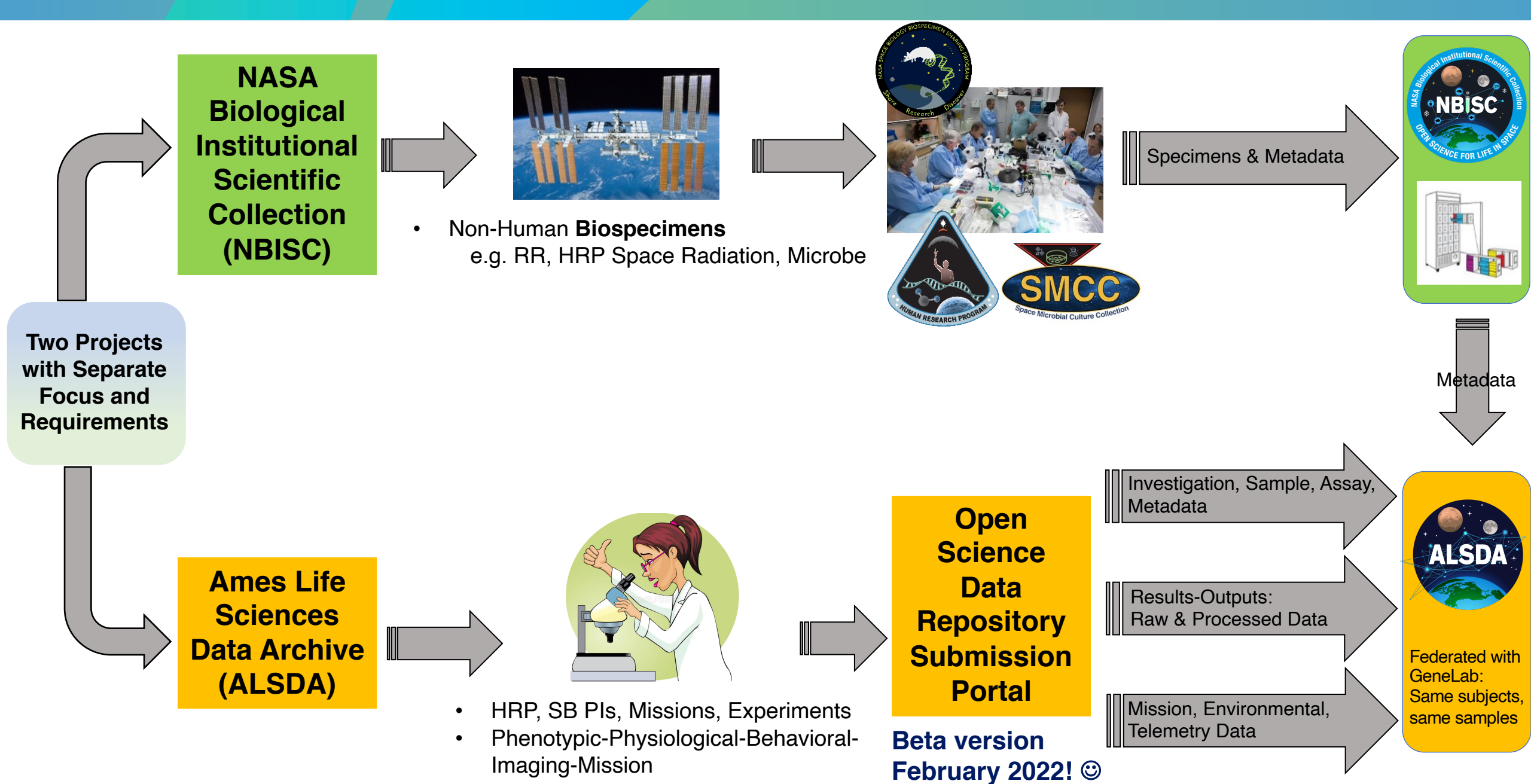
# Expanding Repository Data Available For Sharing And Knowledge Discovery

National Aeronautics and  
Space Administration



Ryan T. Scott, ALSDA Scientist  
HRP-IWS, Wednesday, Feb 9, 2022  
Contact: [ryan.t.scott@nasa.gov](mailto:ryan.t.scott@nasa.gov)

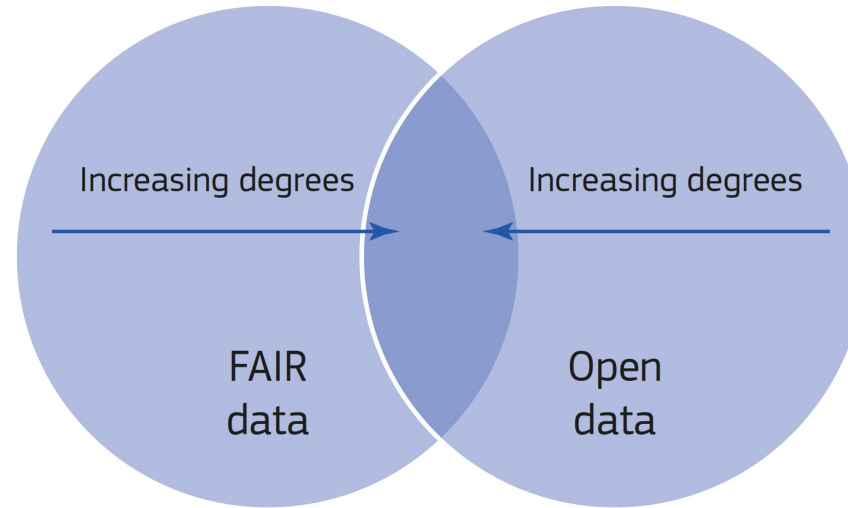




# Nurturing a Data Sharing Culture: Secure & Maximally 'Open' Science

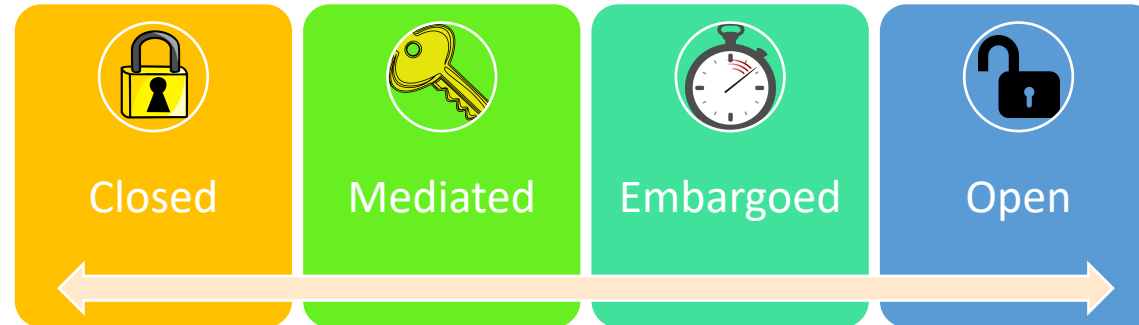
## Is FAIR Open? In Short, "It Depends."

Credit: Higman et al, 2019 & Shelley Stall ☺



Greatest science potential for reuse?  
When data both FAIR and maximally Open

## Closed vs Open: A Continuum



When data submitted,  
**different levels of controls**

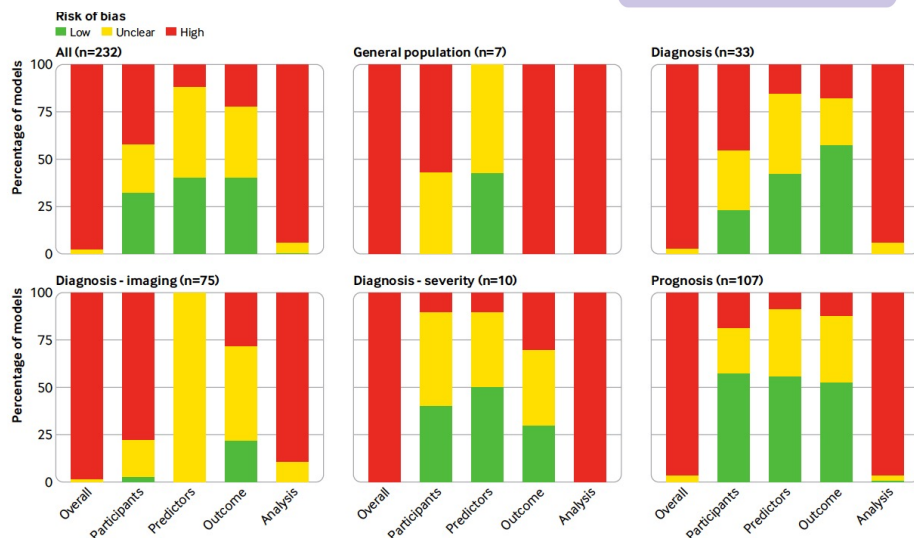
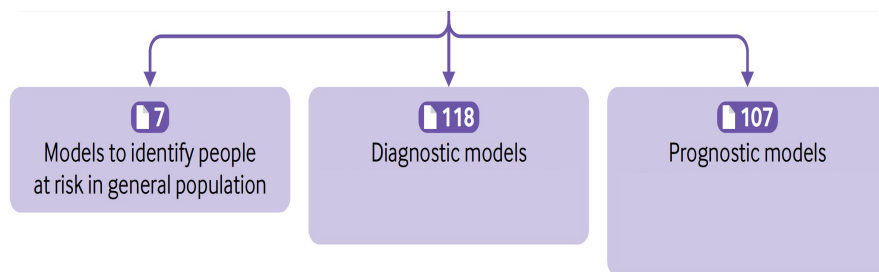
e.g. IACUC, Animal Health Video; IRB, Human PII Data;  
Animal Liver Histology; Microbial Metagenomics

Data should be open as possible, closed as necessary.



# “Data Reuse” & Repository Lesson from AI & COVID-19

China	97
Italy	23
United States	17
South Korea	10
France	5
Singapore	4
Turkey	4
Brazil	3
Spain	2
United Kingdom	2



**Hundreds of AI tools have been built to catch covid. None of them helped.**

Some have been used in hospitals, despite not being properly tested. But the pandemic could help make medical AI better.

By Will Douglas Heaven

July 30, 2021

**MIT  
Technology  
Review**

## Positives

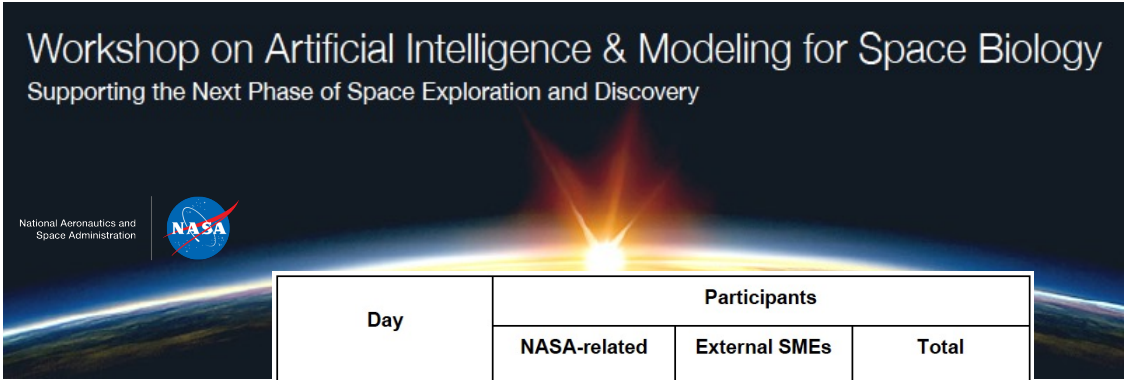
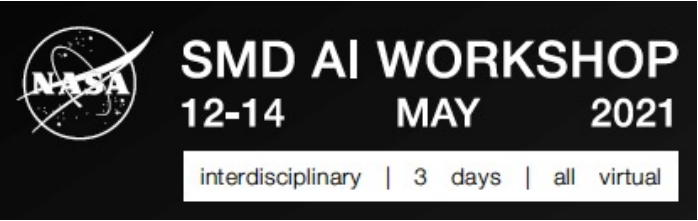
- Modelers, Bioinformaticians, Clinicians Collaborating ‘OPEN’
- Clinical/Biomedical Open Science Data Sharing
- OpenSAFELY, N3C, COG-UK, DECOVID, Royal Society RAMP

## Weaknesses

- AI Readiness, Harmonization of Heterogenous Data
- Assay & Metadata; Biomedical & Science Standards
- Data Availability & Open Accessibility
- Inequality & Exclusion
- Communication: Findings and Uncertainties



# ALSDA and GeneLab: AI-Readiness, Metadata Standards



DAY01  
SCIENCE DATA:  
OPEN, AI READY,  
AND ETHICAL USE

DAY02  
TOOLS, SERVICES,  
WORKFLOWS, AND  
PLATFORMS TO  
CATALOG AND SHARE  
ML DATA AND MODELS

DAY01  
FOCUS AREA 01  
STANDARDS  
FOR AI  
READINESS

DAY02  
FOCUS AREA 04  
REPRODUCI-  
BILITY

DAY01  
FOCUS AREA 02  
DATA SPARSITY  
AND  
HETEROGENEITY

DAY02  
FOCUS AREA 05  
CATALOGING  
AND SHARING  
AI READY DATA  
AND MODELS

DAY01  
FOCUS AREA 03  
UNCERTAINTY  
AND BIAS

DAY02  
FOCUS AREA 06  
COMPUTATIONAL  
PLATFORMS

- AI Readiness, Harmonization of Heterogenous Data
- Assay & Metadata Science Standards
- Data Availability & Open Accessibility

Day	Participants		
	NASA-related	External SMEs	Total
Thursday, June 24	54	48	105
Friday, June 25	39	42	83

arXiv.org > q-bio > arXiv:2112.12554

Quantitative Biology > Other Quantitative Biology

[Submitted on 22 Dec 2021]

**Beyond Low Earth Orbit: Biomonitoring, Artificial Intelligence, and Precision Space Health**

Ryan T. Scott (1), Erik L. Antonsen (2), Lauren M. Sanders (3), Jaden J.A. Hastings (4), Seung-min Park (5), Graham Mackintosh (6), Robert J. Reynolds (7), Casey S. Greene (10), Benjamin S. Glicksberg (11), Corey A. Theriot (12 and 13), Daniel C. Berrios (1), Jack Miller (1), Joel Babbord (14), Richard Barker (15),

arXiv.org > q-bio > arXiv:2112.12582

Quantitative Biology > Other Quantitative Biology

[Submitted on 22 Dec 2021]

**Beyond Low Earth Orbit: Biological Research, Artificial Intelligence, and Self-Driving Labs**

Lauren M. Sanders (1), Jason H. Yang (2), Ryan T. Scott (3), Amina Ann Qutub (4), Hector Garcia Martin (5 and 6 and 7), Daniel C. Berrios (3),

**Machine Learning, Artificial Intelligence and Data Modeling for the Next Decade of Space Biology Research and Astronaut Health Support**

- Lauren M. Sanders, Blue Marble Space Institute of Science, Space Biosciences GeneLab, NASA Ames Research Center, (530) 409-2174, [lauren.m.sanders@nasa.gov](mailto:lauren.m.sanders@nasa.gov)  
- Ryan T. Scott, KBR, Space Biosciences Division, NASA Ames Life Sciences Research Center, (650) 316-9901, [ryan.t.scott@nasa.gov](mailto:ryan.t.scott@nasa.gov)

**Open Science for the Next Decade of Life and Physical Sciences Research for Deep Space Exploration**

Authors:

- Ryan T. Scott, KBR, Space Biosciences Division, NASA Ames Life Sciences Data Archive, NASA Ames Research Center, (650) 316-9901, [ryan.t.scott@nasa.gov](mailto:ryan.t.scott@nasa.gov)  
- Lauren M. Sanders, Blue Marble Space Institute of Science, Space Biosciences Division, NASA GeneLab, NASA Ames Research Center, (530) 409-2174, [lauren.m.sanders@nasa.gov](mailto:lauren.m.sanders@nasa.gov)

The National Academies of  
SCIENCES • ENGINEERING • MEDICINE



(Credit: SMD AI Workshop: <https://doi.org/10.5281/zenodo.5708218>)

NASA Biological Workshop pre-prints: <https://arxiv.org/abs/2112.12554> ; 2022 NASA Human Research Program Investigators' Workshop

<https://arxiv.org/abs/2112.12582> : NASEM CBPSS links)

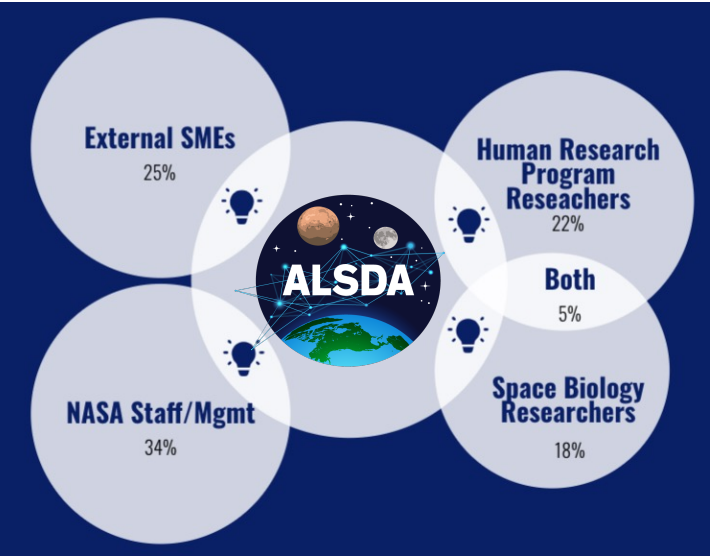
[ryan.t.scott@nasa.gov](mailto:ryan.t.scott@nasa.gov)

# ALSDA Science Community-Driven Curation Standards

ALSDA Analysis Working Group:

- 4 Meetings
- July, Sept, Oct, Dec '21

~100 members  
~55/meeting



Email to learn more and join!  
arc-dl-alsda@mail.nasa.gov

Assay Metadata Configurations	Drafted	AWG Covered	Portal	Dataset Creation
Bone Microstructure (MicroCT)	✓	09/08/21	✓	✓
Behavior (Novel Object Recognition)	✓	09/08/21	✓	✓
Molecular/Cellular Imaging (Lt/Fluor Microscopy)	✓	09/08/21	✓	✓
Flow Cytometry (Flow Cytometry)	✓	09/08/21	✓	✓
Behavior (Elevated Plus Maze)	✓	12/08/21	✓	✓
Behavior (Open Field)	✓	12/08/21		
Behavior (Gait)	✓	12/08/21		
Protein Analysis (Western Blot/Immunoblot)	✓	12/08/21	✓	✓
Calcium Uptake (Spectrofluorometry)	✓	12/08/21	✓	✓
Behavior (Barnes Maze)	✓	12/08/21		
Osteocellular (Histomorphometry)	✓	02/16/22		✓
Mechanical Test (3pt-Bend)	✓	02/16/22		
Intra-Ocular Pressure (Rebound Tonometry)	✓			
Blood Analysis (Serum Metabolites)				
Echocardiogram (Ultrasonography)	✓	02/16/22		
Protein Analysis (ELISA)	✓			
Behavior (Radial Arm; Water Maze)				
Behavior (Morris; Water Maze)				
Muscle Physiology (Muscle Fiber Typing)				
Mineral Density and Composition (DXA)				
Neurophysiology (Electrophysiological Recordings)				
Physiology (Blood Pressure)				
Physiology (Pulse Oximetry)				
Metabolites (HPLC with ECD)				
Cardiovascular Imaging (MRI)				
Neuroimaging (MRI)				
Eye Microstructure (microCT)				
Grip Force (Force Transducer)				
Electron Microscopy (Scanning)				
Electron Microscopy (Transmission)				
Behavior (Spatial Novelty Y Maze)				
Behavior (Tail Suspension Test)				
Behavior (Startle Test)				
Behavior (Prepulse Inhibition)				
Behavior (Contextual Fear Conditioning)				
Behavior (Rotarod)				
Behavior (Water Maze)				
Behavior (Wire Hang)				
Behavior (Escher Staircase Track)				

ALSDA AWG:  
-10 'Ready' Assay Configs from Feedback

ALSDA Assay Metadata, Image, Outcome Measure Configuration for microCT	Micro-Computed Tomography (microCT; $\mu$ CT)
File Folders will contain: Study Metadata File, $\mu$ CT Assay Log	Measurement: Bone Microstructure
Supporting Literature: ALSA Assay Metadata Configuration for Western Blot/Immunoblot	Western Blot / Immunoblot
File Folders will contain: Study Metadata File, Assay Results (Outputs; txt files raw values), Western Blot Images	
Supporting Literature: ALSA Assay Metadata, Setup, Outcome Measure Configuration for Barnes Maze	Barnes Maze
File Folders will Optimally Contain: Study Metadata File, Processed Data Outcomes File, Image of Barnes Maze, Image of Aversion device, Image of the Room, Raw Training Session Video	Measurement: Behavior Ontology: <a href="https://ncit.nci.nih.gov/ncitbrowser/pages/concept_details.jsp?termId=NCIT_C11332">https://ncit.nci.nih.gov/ncitbrowser/pages/concept_details.jsp?termId=NCIT_C11332</a>
Supporting Literature: ALSA Assay Metadata, Setup, Outcome Measure Configuration for Gait	Gait
File Folders will Optimally Contain: Study Metadata File, Processed Results/Outcomes File, Image of Gait Chamber and/or treadmill, Baseline Training Session Video	Measurement: Behavior Ontology: <a href="https://ncit.nci.nih.gov/ncitbrowser/pages/concept_details.jsp?termId=NCIT_C11332">https://ncit.nci.nih.gov/ncitbrowser/pages/concept_details.jsp?termId=NCIT_C11332</a>
Supporting Literature: ALSA Assay Metadata, Setup, Outcome Measure Configuration for Open Field	Open Field
File Folders will Optimally Contain: Study Metadata File, Processed Data Outcomes File, Image of EPM Arena Image, Image of Familiar Objects, Image of Novel Object, Raw Training Session Video, Raw Testing Session Video	
Supporting Literature: Komada, JOVE, 2008; <a href="https://doi.org/10.3791/1088">https://doi.org/10.3791/1088</a>	
Supporting Literature: Wolf, NatProtocols, 2007; <a href="https://doi.org/10.1038/nprot.2007.44">https://doi.org/10.1038/nprot.2007.44</a>	
Parameter	Example Value
Tracking and Analysis system (name/company/version)	ALSDA ASSAY Metadata for EPM
Other Behavioral assays conducted prior or concurrent to EPM (free text)	COGNITIVE ASSAY ARRANGEMENT
Vector of the sequence of all behavioral tests performed in order, denoting position of EPM (free text)	e.g. Ethovision XT 12.0
EPM Assay Repeated (unit: YES/NO)	e.g. Open Field, Elevated Plus Maze, NOR
Number of times EPM Assay Repeated (unit: numerical)	e.g. 1. Open Field, 2. Elevated Plus Maze, 3. NOR, 4. Rotorod, 5. Morris Water Maze
Subject Handling Frequency and Technique (free hand)	e.g. No
	e.g. 0
	PHYSICAL ENVIRONMENT
	e.g. Twice a day, scruffline posterior neck



# KUDOS and THANKS! Specific AWG Members, Others Involved



Siddhita Mhatre



Janani Iyer



Josh Alwood



Egle  
Cekanaviciute



Model Translation & Space Biology Integration (MTSBI)



Susanna Rosi



Kira Rienecker



University of California  
San Francisco



Val Fajardo



Jessica Braun



Andrew Wyrobeck



Svetlana Komarova



Mattias Neset



Greg Nelson



Marie Mortreux



Mary Boussein



Harvard  
Medical School



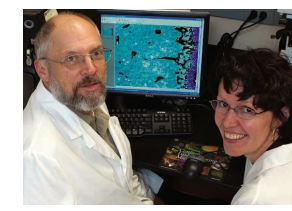
Rich Britten



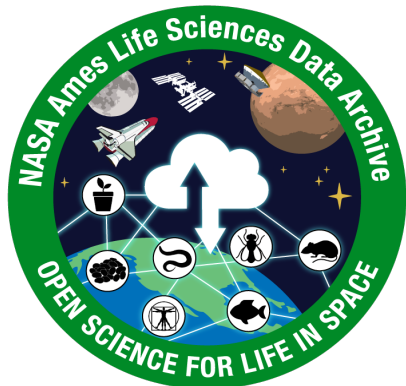
Jeffrey Willey



Sunny Narayanan



Russell Turner



Dan Berrios



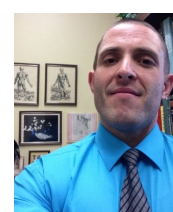
San-huei Lai Polo



Sylvain Costes



Evelyn Wong



Ryan Scott



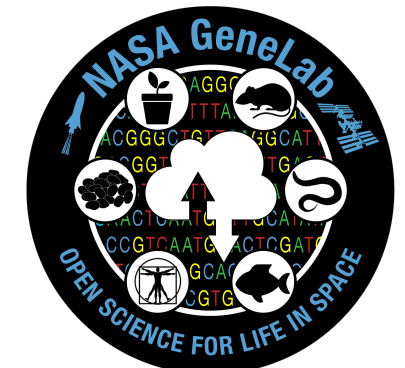
Danielle Lopez



Samrawit  
Gebre



NASA Open Science for Life in Space: ALSDA and GeneLab







# Multi-Project Submission Portal – Beta version February 2022!


- Submit Directly to ALSDA, Curate Datasets According to Standards!


Welcome to NASA GeneLab - the first comprehensive space-related omics database; users can upload, download, share, store, and analyze spaceflight and spaceflight-relevant data from experiments using model organisms.

**Data Repository**  
Search and upload spaceflight datasets

**Analyze Data**  
Perform large-scale analysis of biological omics data

**Environmental Data**  
Radiation data collected during experiments conducted in space

**Collaborative Workspace**  
Share, organize and store files

**Submit Data**  
Have space-relevant data to submit to GeneLab?

**Visualize Data**  
Interact with GeneLab processed data

Search Data

☐ All ☒ GeneLab ☐ NIH GEO ☐ EBI PRIDE ☐ ANL MG-FAST ☒ **ALSDA**

Search Filters (GeneLab Only)

Project Type

Factors

Organisms


Assay Type

Clear

Show Only:

☐ Studies With Visualizations

Page 1 of 13 (Total Studies: 302) Next >  
Studies Per Page: 25

**ALSDA**  
GLDS-426

**Effects of Spaceflight on Bone Microarchitecture in the Axial and Appendicular Skeleton in Growing Ovariectomized Rats**

Organisms	Factors	Assay Types	Release Date	Description
Rattus norvegicus	Spaceflight Ovariectomized Age	Radiography	25-Feb-2020	This study investigated the effects of a 14-day spaceflight on bone mass, density and microarchitecture in weight bearing (femur and humerus) and non-weight bearing (2nd lumbar vertebra and calvarium)...

**GLDS-401**

**Alternative splicing regulates the physiological adaptation of the mouse hind limb postural and phasic muscles to microgravity**

Organisms	Factors	Assay Types	Release Date	Description
Mus musculus	Spaceflight Tissue	transcription profiling	25-Jun-2021	We sought to comprehensively elucidate the transcriptomic underpinnings of microgravity-induced muscle phenotypes in mice by evaluating both differential gene expression (DGE) and changes in alternati...


Description Samples **Assays** Protocols Files Study Validations

+ Add Assay

- Histone Modification Profile
- Novel Object Recognition
- Environmental Gene Survey
- Transcription Factor Binding Site Identification
- Post-Transcriptional Modification Profiling
- Histomorphometry
- Protein Identification
- Protein-Protein Interaction Detection
- Radiation Measurement
- Copy Number Variation Profiling
- Radiography

Adding Phenotypic ALSDA Assays to Portal

Cancel

**GEODE**

NEWSLETTER SIGNUP  
Email Address \*

Questions and Feedback  
SITE INFORMATION  
NASA GeneLab Overview  
Terms and Conditions

NASA Ames Space Biosciences Division  
NASA Life Sciences Data Archive  
NASA Physical Science Informatics  
Center for the Advancement of Science

# Science Data Viz Tools: GeneLab & ALSDA In Unison



GeneLab Visualization

+ Add Visualization

GLDS-154

Title: Low dose ionizing radiation treated lymphoblastoid cells  
Organism(s): Homo sapiens  
Number of Genes: 3  
Number of Samples: 29

Group Selection

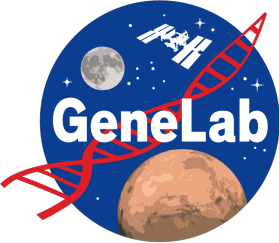
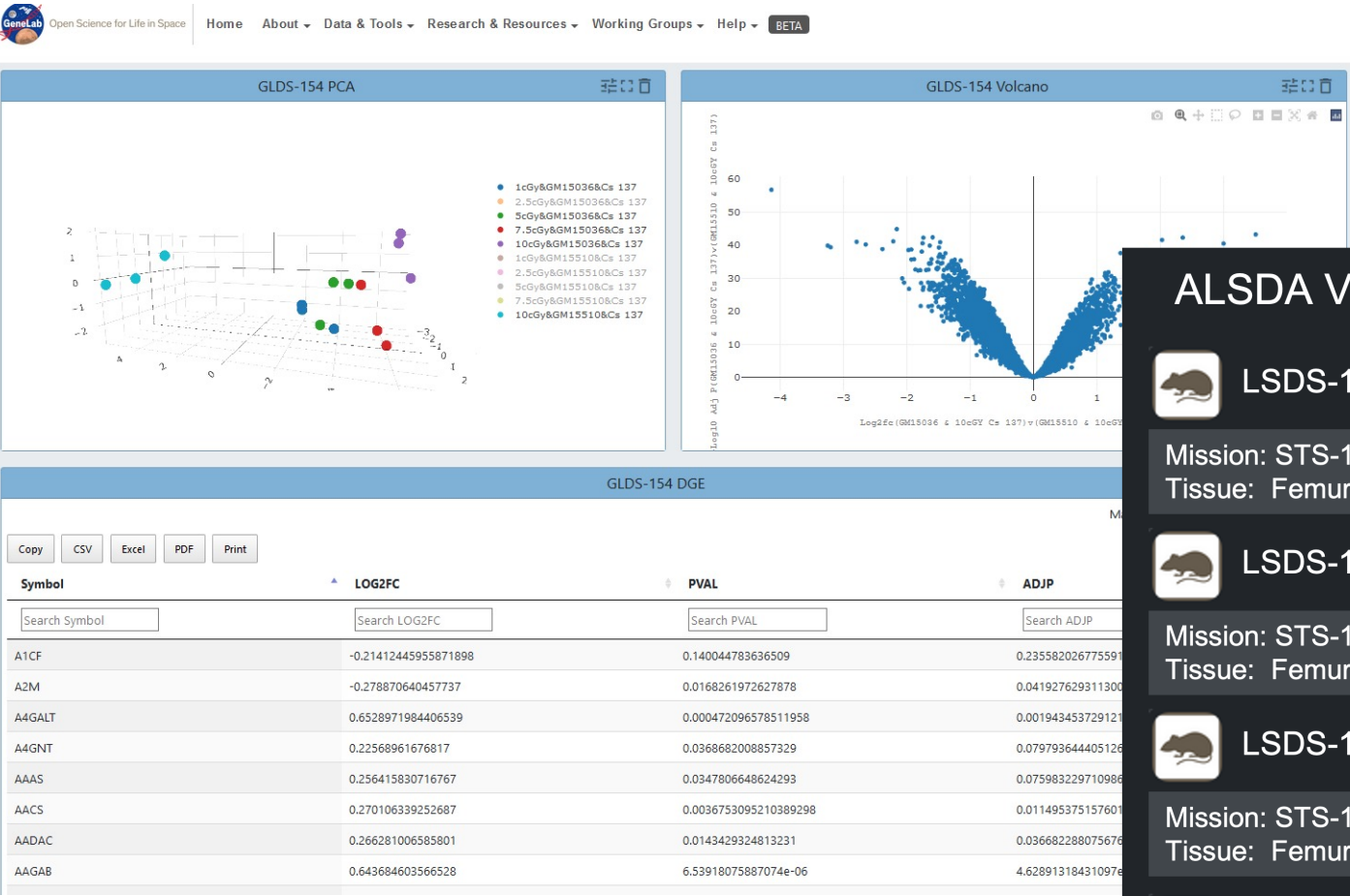
Group 1: GM15036

10cGY Cs 137

Group 2: GM15510

10cGY Cs 137

Update



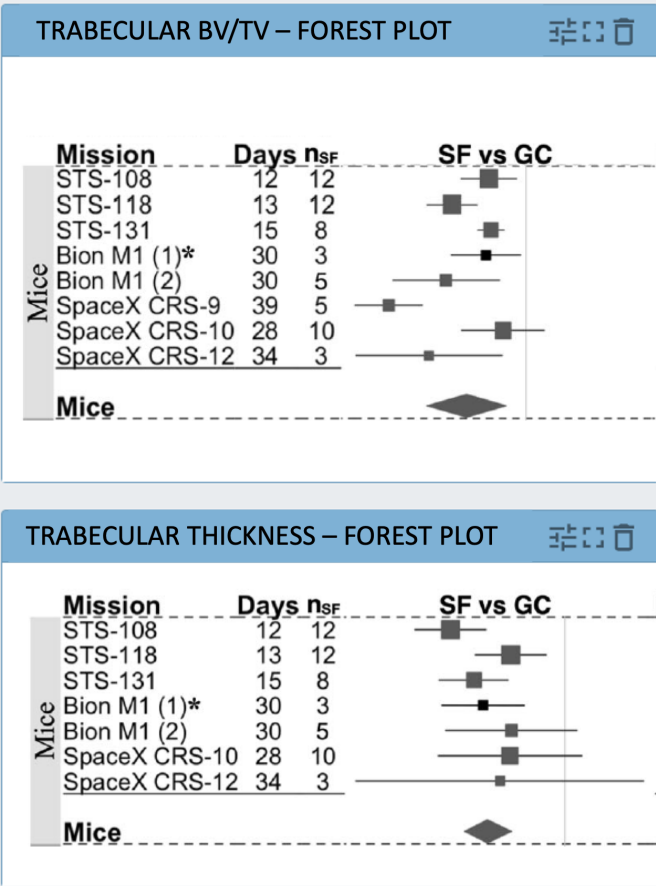
ALSDA Visualization

**LSDS-110**  
Mission: STS-108  
Tissue: Femur (D)

**LSDS-115**  
Mission: STS-118  
Tissue: Femur (M)

**LSDS-117**  
Mission: STS-131  
Tissue: Femur (M)

**LSDS-89**  
Mission: Bion M1 (1)  
Tissue: Femur (M,D)



(Credit: NASA GeneLab; Fu et al., 2021, PMID: 34075059; PI: Svetlana Komarova)

# Assess Science Data AND Environmental, Mission Data

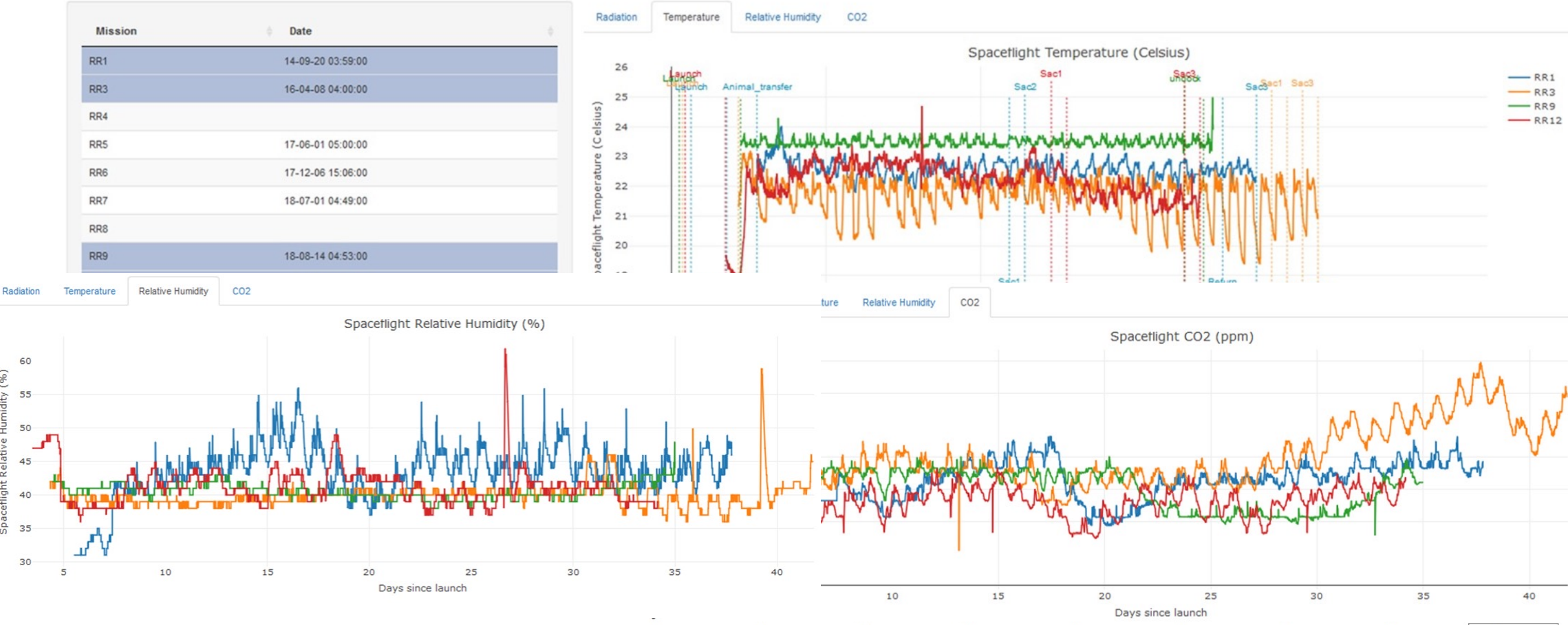
## Rodent Research Environmental Data

NASA GeneLab

Individual missions

Compare

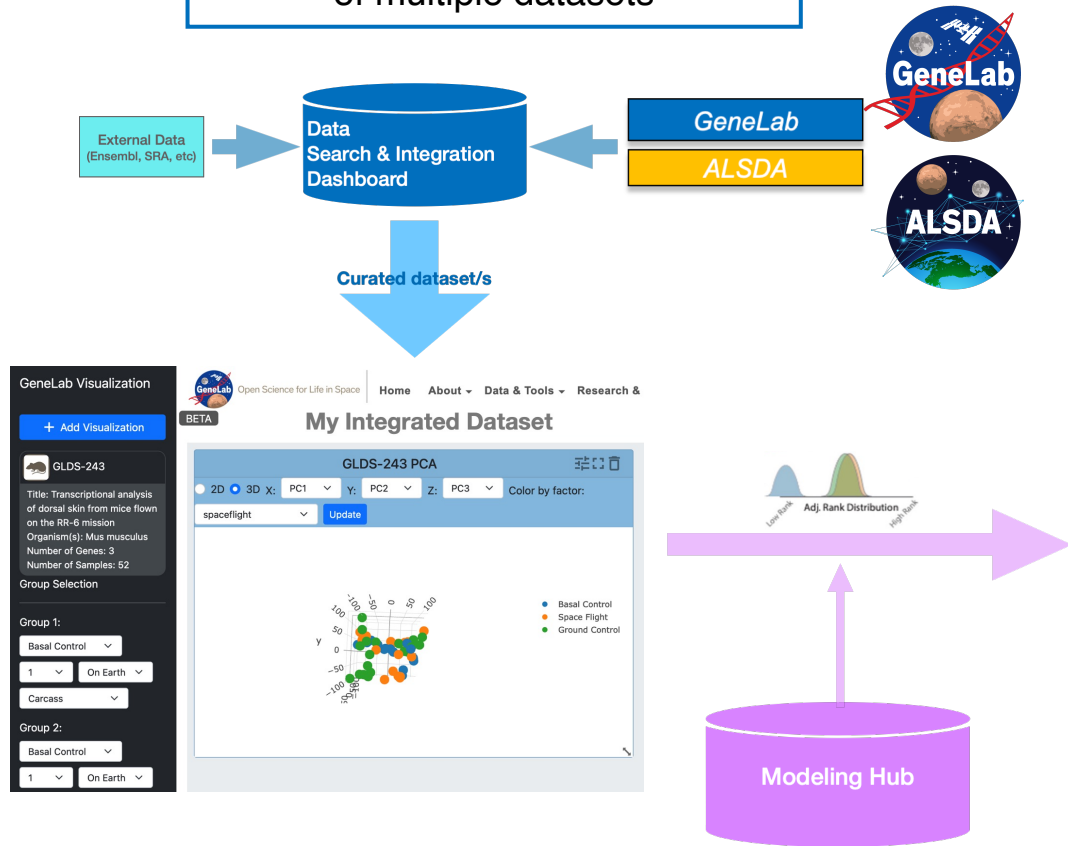
### Compare Environmental Data Among Datasets





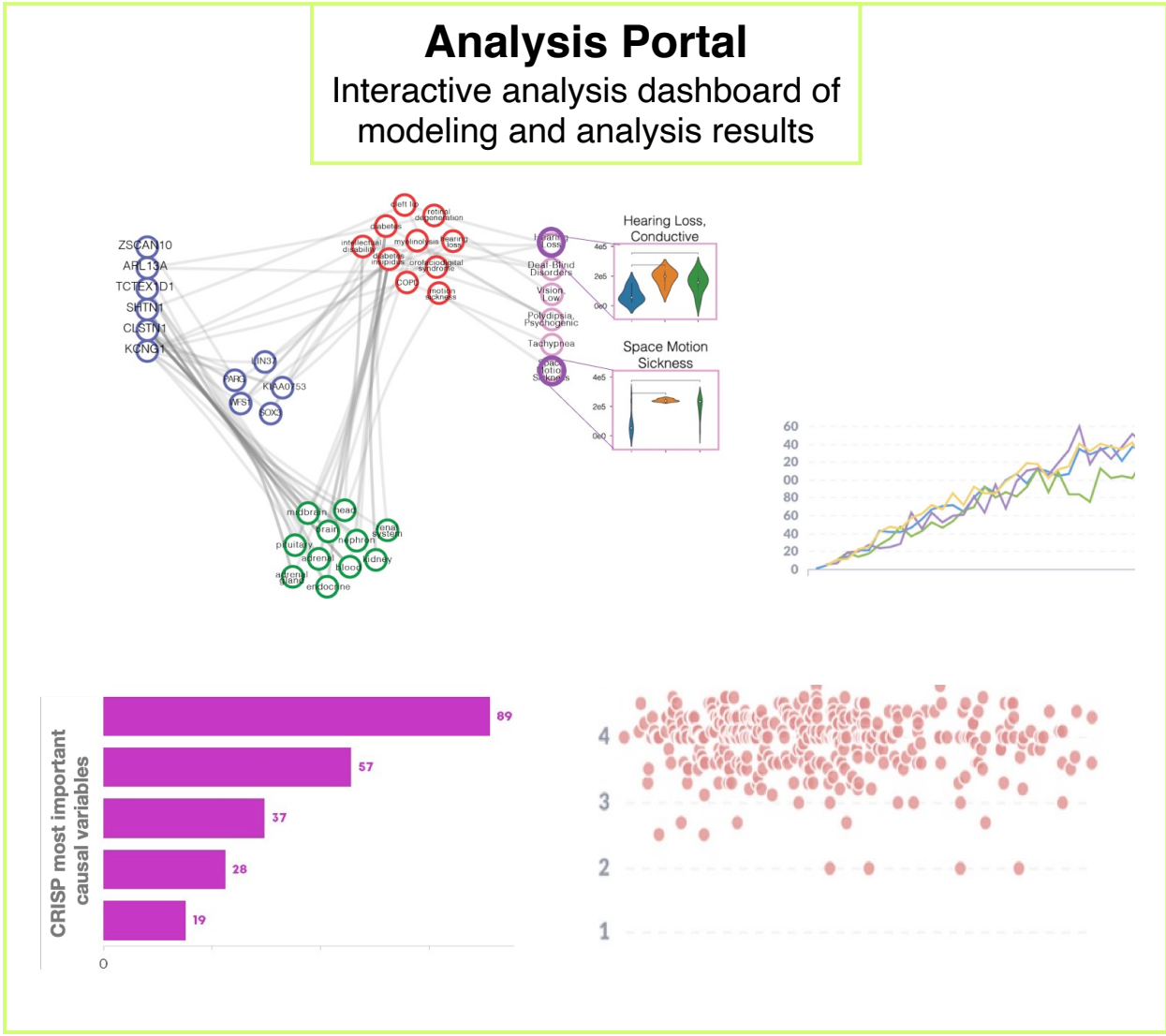
# New! Open Science Modeling Hub and Analysis Portal

Streamlined Data Integration  
of multiple datasets



**Modeling Hub**  
Automated pipelines for a  
suite of machine learning  
and modeling tools

**Analysis Portal**  
Interactive analysis dashboard of  
modeling and analysis results



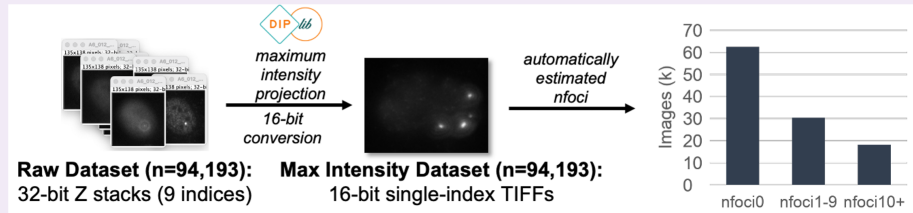
# ALSDA Data Currently in Reuse

## Benchmark Microscopy Dataset

-Huge amounts of microscopy data in space biology, time consuming, manual annotate

### Approach:

-Radiation exposure microscopy DNA damage dataset, distinct foci (PI: Costes)

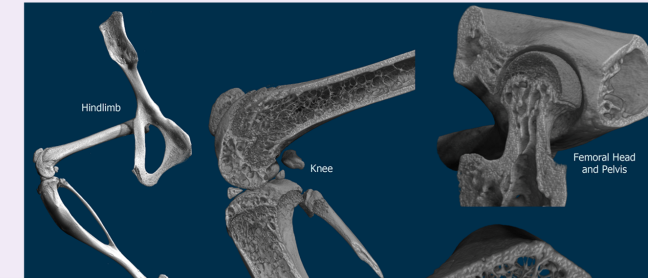


## Benchmark microCT Dataset

-CT is key to assess space biological bone impacts

### Approach:

-Mouse mCT dataset, both spaceflight and group (PI: Almeida)



## Genomic to Phenotypic: CRISP and Hepatic Dysfunction

-Transcriptomics, Histology; Four Spaceflown Rodent Liver Datasets

-Ensemble Learning; Causal Research and Inference Search Platform



### ALSDA Visualization

**LSDS-110**

Mission: STS-108  
Tissue: Femur (D)

**LSDS-115**

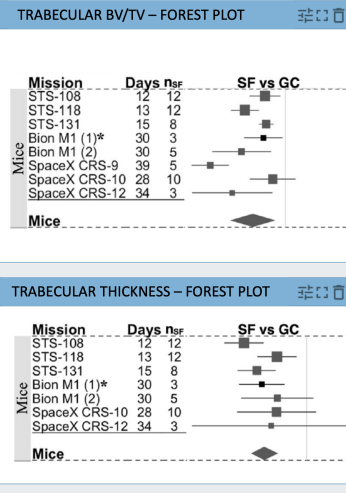
Mission: STS-118  
Tissue: Femur (M)

**LSDS-117**

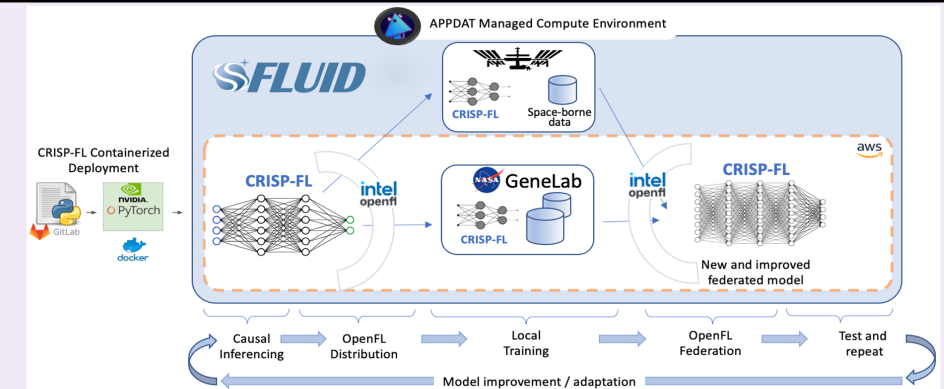
Mission: STS-131  
Tissue: Femur (M)

**LSDS-89**

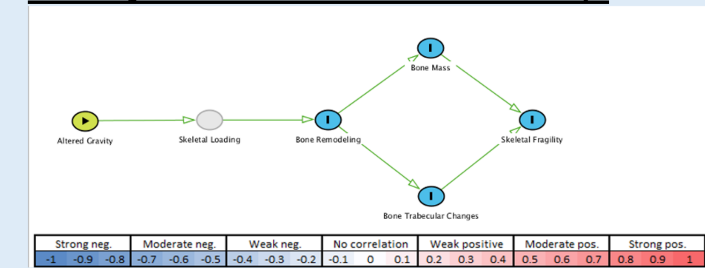
Mission: Bion M1 (1)  
Tissue: Femur (M,D)



## Federated causal inference; Earth data and ISS spaceborne data

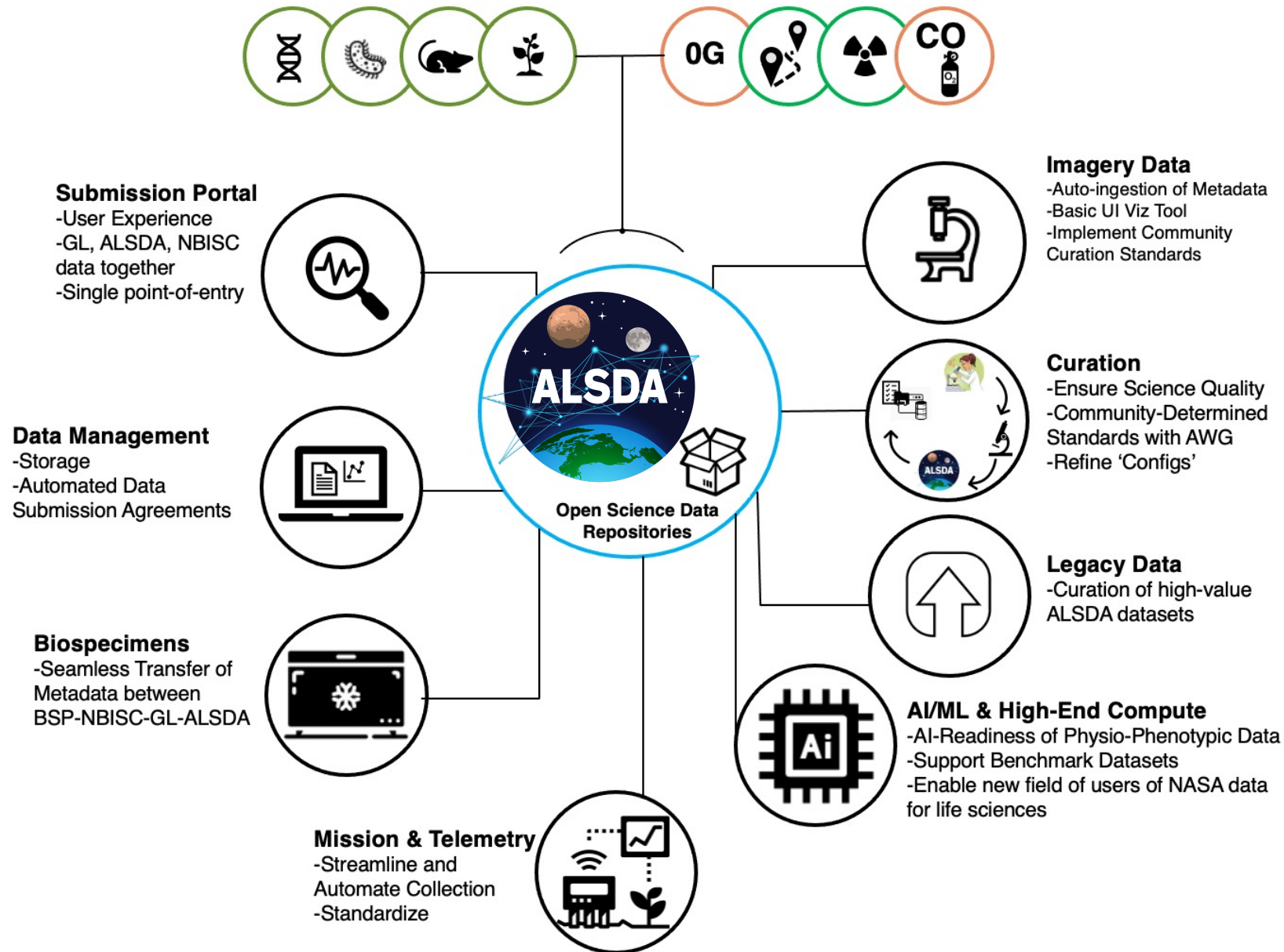


## Quantify Bone Risk: DAG Proof of Concept

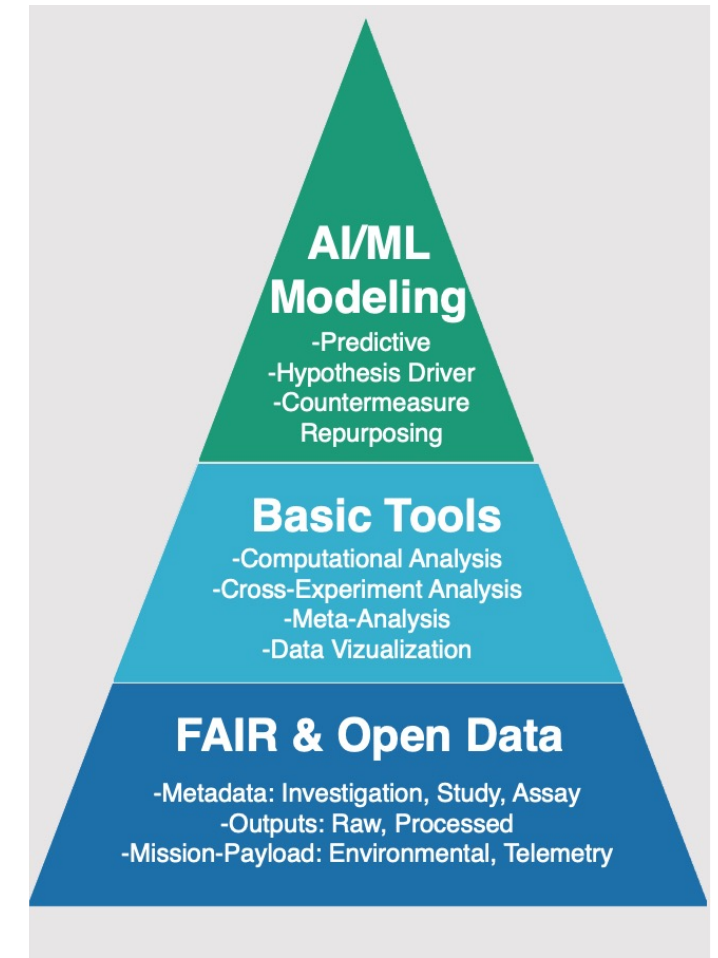


(Credit: BMs: Sylvain Costes & Eduardo Almeida; CRISP: Makenna Myrick, James Casaletto, Sanders et al., 2021; FLUID: Graham Mackintosh, 2022; DAG: Rob Reynolds, et al., 2021; ALSDA Vis, Fu et al., 2021, Svetlana Komarova)

# Up Next



# Big Picture







# Open Science for Life in Space (Open Science Data Repositories)

## ALSDA

- Danielle Lopez
- Evelyn Wong
- Alan Wood
- Kira Rienecker
- Sylvain Costes

## GeneLab & Data System Support

- San-huei Lai Polo
- Sam Gebre
- Dan Berrios
- Ana Uriarte Acuna
- Nico Garcia
- Jamie Bales
- Jeff Holland

## AI for Life in Space NBISC

- James Casaletto
- Lauren Sanders
- David Loftus
- Graham Mackintosh
- Adrienne Hoarfrost

## NBISC

- Joey Varelas
- Alison French
- Ahleah Rohr Daniel



## Biospecimen Sharing Program

- America Reyes
- Rebecca Klotz
- Yi Chun Chen
- Lauren Liddell
- Christina Lim
- Karin Perkins
- Hami Ray



## LSDA

- Diedre Thomas
- Sara Jorgensen
- Rachel Shoop
- Jessica Keune



## Collaborators

### ALSDA AWG

- ~100 Members

### UCSF SPOKE Team

- C. Nelson, K. Sorman, S. Baranzini

### 2021 AI Workshop Participants

- ~100 Participants

### Frontier Development Lab 2020 & 2021 Astronaut Health Teams



## Stakeholders and Management

### NASA Space Biology Program

### NASA Biological and Physical Sciences

### NASA Human Research Program

